

have been carefully brought up to date. They furnish a trustworthy account of the essential facts of anatomy and development, but as occurs in the case of the other groups described in this volume, the problem of their affinities is not set forth with that clearness which is so essential to its comprehension.

Considered as a whole, the volume has not that illuminating and suggestive value which distinguished the earlier volumes of the "Treatise." Nevertheless it will remain for some time the chief work of reference in the language on the anatomy and classification of the groups with which it deals.

PRIMARY BATTERIES.

Primary Batteries: their Theory, Construction and Use.

By W. R. Cooper. Pp. 4+324. (London: *The Electrician* Printing and Publishing Co., Ltd., on date.) Price 10s. 6d. net.

MR. W. R. COOPER'S book directs attention to a subject which will always be of great historical interest on account of the remarkable stimulus given to electrical science by the discoveries of Galvani and Volta. At the present time, it is true, the primary battery has yielded to cheaper and more convenient sources of electrical energy, and the position which it holds in electrical engineering is comparatively insignificant. It is not improbable that before long it will be displaced from almost all practical applications of electricity and will only be found where the dynamo and accumulator are unavailable. It may, however, be some consolation to those who have not other means at hand to reflect that in the research by which Faraday laid down the fundamental laws of electrolysis he obtained current from a primary battery of the most elementary form. The advantage of amalgamating the zinc had been shown five years earlier (1828) by Kemp, but it was not until 1836 that the first effective depolarising cell, that of Daniell, was described; the invention of the Grove cell followed in 1839. The Leclanché cell, which did not appear until 1868, marks the only other development of the first importance.

In spite of the fact that Volta's discovery is more than a century old, the theory of the primary battery cannot be said to be in a very satisfactory state. Mr. Cooper devotes two chapters to this subject, the first of which deals chiefly with contact-force and the seat of the E.M.F. in the cell. Mr. Cooper, in summing up the various theories, states that "the whole matter (of the seat of the E.M.F.) is largely a question of definition, and is, therefore, of relatively small importance," a conclusion which is not likely to commend itself to those who are anxious to arrive at the truth. In the second chapter, the ionisation theory of Arrhenius is discussed and the calculations of the E.M.F. of a cell from the equations of Helmholtz and Nernst are compared, with results which are not very convincing in either case. The author then passes to a brief consideration of concentration and liquid cells (which are at present only of theoretical interest) and of the thermopile, which, he points out, on account of its high price is not likely to prove a serious competitor to the primary battery.

There follows what may be called the practical part of

the book, in which the various types of existing cells are described and which contains much valuable information collected or directly obtained by the author. Cells are classified under three headings, one-fluid, two-fluid and dry cells. In the first division, the principal examples are the bichromate, Leclanché and copper-oxide cells. Some interesting tests carried out by the author show that in the bichromate cell the most suitable depolariser to use is chromic acid, which gives a discharge curve as good as that given by either sodium or potassium bichromate and is also more convenient and as cheap. The two-fluid cells include the Daniell, with its numerous derivatives, and the Grove and Bunsen cells, which on account of their high E.M.F. and low internal resistance are especially suitable where heavy currents are required. All the dry cells are modifications of the Leclanché and do not differ much from one another except in details of construction. It is somewhat surprising to find that, weight for weight, the dry cell is superior to the wet form of Leclanché. Against this must be set the somewhat higher initial cost and the advantage of the possibility of regenerating an exhausted wet cell, though this latter consideration, as Mr. Cooper shows, is in reality somewhat illusory. The usefulness of this part of the book is greatly increased by the numerous discharge curves which are included and by the many very clear drawings illustrating the various cells described.

The last two chapters deal with standard cells and carbon-consuming batteries. The standard cell is, and is likely always to remain, of the highest practical importance; the chapter dealing with it is consequently of great interest and value, as it contains in a convenient form most of the hitherto scattered information on this subject. The table of constants of standard cells shows that the results of recent determinations point to the value 1.433 volts being more nearly correct for the E.M.F. of a Clark cell at 15° C. than the generally accepted (and legal) value of 1.434 volts. The Helmholtz cell, recently modified by Hibbert, is of interest on account of its having an E.M.F. of 1 volt at 15° C. and also a very low temperature coefficient, though in this latter respect it is inferior to the cadmium cell. The final chapter, on the carbon-consuming cell, is, unfortunately, only a record of failures. It would seem as if commercial success, if ever to be achieved, will have to be sought on entirely new lines. But the problem is not likely to lose its fascination so long as the overall efficiency of steam generation remains as low as 6 per cent. whilst the primary battery holds out a prospect of the attainment of an efficiency of 73 per cent. or more.

M. S.

A MEMOIR ON MORAINES.

Geschichte der Moränenkunde. Von Dr. August Böhm Edlen von Bömersheim (*Abhandlungen der K. K. Geographischen Gesellschaft in Wien*, iii. Band, No. 4). Pp. viii+334; 4 plates, 2 figures in text. (Wien: R. Lechner, 1901.)

AS to the history of moraines, the author might fairly say "What there is to know, I know it." By patient research in libraries he has collected a great mass of information, of which the present volume is a summary. It also contains, besides the main subject, a

full account of drums or drumlins, which in some way or other are closely related to moraines, the proceedings of the Glacier Conference held at Gletsch in August, 1899, a section on the distinctions and nomenclature of moraines, a glossary and list of synonyms, and indices of authors and subjects. After answering, by quotations from writers, beginning with Sebastian Münster in 1544, the question, What is meant by a glacier? he passes on to moraines, which are at first mentioned casually, without any definite name. This does not appear till rather late in the eighteenth century, about the time of De Saussure. The word, no doubt of patois origin, was not admitted to dictionaries or encyclopedias till well on in the following century. According to Littré its origin is unknown, though it evidently is related to the Low Latin *morena*—bank of stones—which also appears in Italian under the older form, *mora*, and in Piedmontese *murena* designates earth piled in a bank by the side of a field. We also learn that in the German Alps the names *Ganda*, *Gandecken*, *Mårenes* and *Murren* are used, the last perhaps restricted to the Ötztal district. Then follows a long series of abstracts or extracts chronologically arranged from the works of travellers by whom moraines have been noticed or described.

Before the first quarter of the nineteenth century the accounts become definite, von Charpentier in 1819 pointing out that some of the material in a terminal moraine travelled on, some under, the ice. The different varieties are clearly distinguished by F. J. Hugli in 1830, from which time the study assumes a scientific aspect, J. de Charpentier four years later clearly recognising old moraines. They began to be identified in other countries; C. Martins, in 1841, compared the glaciers of Spitzbergen and the Alps, and showed that moraines were also associated with the former. At the same time the study of everything associated with glaciers received a fresh impulse from the investigations of Agassiz, and from this date ground moraine (*grund moräne* or *moraine profonde*) begins to figure in books (though we believe he spoke only of *couche de boue*). Of this, perhaps, not so much is now heard as some quarter of a century ago, when a glacier might have assumed *Diruit*, *Ædificat* as a motto, for it was credited with scooping out a deep lake basin in one place and laying down a thick cushion of "till" in another. The most important additions to knowledge since the valuable summary in Dr. Heim's "Handbuch der Gletscherkunde" (1884) have been Prof. T. C. Chamberlin's observations, completed by his studies in Greenland, that in large glaciers an amount of material, greater than was generally supposed, is transported embedded in the ice (englacial), particularly in the lower part, in which, owing to shearing movements, it often assumes a rude stratification. Thus in certain circumstances, a very remarkable instance of which was described in 1898 by Profs. Garwood and Gregory, materials may even be carried uphill for a certain distance.

Students will find the twenty pages containing a summary of what has been written about drumlins or drums very useful for reference, though whether they will arrive at a clear conviction of how these were formed is less certain. That, however, is the fault of the subject, not of the author, for they are among the greatest puzzles

in glacial geology. In America, in some districts of which they seem to be especially well developed, they form oval hills, occasionally as much as a mile in length, their breadth being about two-thirds of this, and they rise, according to their area, from 25 to 200 feet in height. They are composed of similar material to till, with slight or no signs of stratification, and when numerous show a rude parallelism. The principal facts in regard to their structure are generally admitted, but here unanimity ceases.

We owe a debt of gratitude to the author of this work. In such a subject, indeed in any one connected with glaciers, the task of searching through its literature is most laborious, and as the student often finds hypothetical inferences more abundant than careful descriptions of facts, he is tempted to doubt, as did the charity boy when he got to the end of the alphabet, "whether it was worth going through so much to get to so little." This book, with its summaries and useful indices, will enable him to ascertain what observations are on record and what hypotheses have been formulated. He will also find, in the account of the conference in 1899, the latest classifications proposed (in which, we think, over-minute distinctions are attempted), and will be enabled to begin personal investigations with a general knowledge of previous opinions, more than which is apt to be a hindrance rather than an advantage.

T. G. B.

CHEMISTRY OF PAINTS.

The Chemistry of Pigments. By E. J. Parry and J. H. Coste. Pp. viii + 280. (London: Scott, Greenwood and Co., 1902.) Price 10s. 6d. net.

THIS book is divided into four parts or chapters. The first of these, occupying just seventeen pages, deals with the optical origin of colour; the second chapter, entitled the "Application of Pigments," discusses in separate sections their purely artistic uses, their decorative employment and their protective qualities. These sections are followed by descriptions of the methods of applying pigments, including pastel, water-colour, tempera, oil-painting, ceramic painting, enamelling, glass and mosaic. Large use is made, in the first of these sections of chapter ii., of Russell and Abney's 1888 report on the "Action of Light on Water-Colours," and in the third section of Mr. Harry Smith's recent experiments on the protection against the rusting of iron afforded by many different kinds of paints. The two chapters which constitute the body of the work before us and occupy a couple of hundred pages are entitled respectively "Inorganic Pigments" and "Organic Pigments." Here we find much information of interest and importance in the actual analyses given of individual samples of different pigments and in the notes on methods of examining and testing pigments. But some pigments, such, for instance, as aureolin and cadmium yellow, are treated too summarily in view of their artistic importance, while to other pigments, notably to the large group of "coal-tar lakes," is assigned a treatment which they do not deserve.

And here the question forces itself upon a reviewer's attention, "For what class of readers has this book been written?" The authors speak in their preface of "those who are called upon to use or examine pigments